

1 What is claimed is:

2 1. An electrically programming & sensing unit for a field repairable system-on-a-  
3 chip (SOC) device, said electrically programming & sensing unit comprising:

4 a diode such that a cathode of said diode is connected to a VDD power;

5 an electrically programmable element with a first end connected to an anode of said  
6 diode and to a VPP power;

7 a pull-down transistor configured to conduct current from said VDD power or from  
8 said VPP power to ground through said electrically programmable element when turned on;

9 a latch configured to latch a value from a second end of said electrically  
10 programmable element; and

11 a multiplexor configured to receive a set of external inputs and to control the  
12 operation of said pull-down transistor based on said set of external inputs.

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14 2. The electrically programming & sensing unit of claim 1, wherein said  
15 electrically programmable element has an initial state that is one of a high resistance and a  
16 low resistance and has a programmed state that is the other of said high resistance and said  
17 low resistance.

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19 3. The electrically programming & sensing unit of claim 2, wherein a turn-on  
20 resistance of said pull-down transistor is substantially at least 10 times of said low resistance  
21 and is substantially at maximum  $1/10^{\text{th}}$  of said high resistance.

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1           4.       An electrically programmable circuit for a field repairable system-on-a-chip  
2       (SOC) device, comprising:

3           a high voltage generator configured to supply a VPP power in response to a  
4       program\_enable signal;

5           a scan chain configured to receive address bits indicating whether a redundant row or  
6       a column needs to be activated;

7           an electrically programming & sensing unit configured to receive a signal from said  
8       scan chain, said program\_enable signal, and a power-on-reset signal such that upon activation  
9       of said program\_enable signal, said electrically programming & sensing unit further  
10       configured to be programmed in response to said signal from said scan chain indicating a  
11       defective row or column should be fixed; and

12           a fuse-switch configured to receive an output of said electrically programming &  
13       sensing unit such that said electrically programming & sensing unit is able to  
14       activate/deactivate said fuse-switch.

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16           5.       The electrically programmable circuit of claim 4, further comprises a feedback  
17       connection from an output of said electrically programming & sensing unit to said scan chain.

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19           6.       The electrically programmable circuit of claim 4, wherein said electrically  
20       programming & sensing unit comprises:

21           a diode such that a cathode of said diode is connected to a VDD power;

22           an electrically programmable element with a first end connected to an anode of said  
23       diode and to said VPP power;

1 a pull-down transistor configured to conduct current from said VDD power or from  
 2 said VPP power to ground through said electrically programmable element when turned on;  
 3 a latch configured to latch a value from a second end of said electrically  
 4 programmable element; and  
 5 a multiplexor configured to:  
 6 receive said program\_enable signal and said signal from said scan chain; and  
 7 output a signal which follows said signal from said scan chain to said pull-  
 8 down transistor upon activation of said program\_enable signal.

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 10 7. The electrically programmable circuit of claim 6, wherein said multiplexor is  
 11 further configured to:  
 12 receive said power-on-reset signal; and  
 13 output a signal which follows said power-on-reset signal to said pull-down transistor  
 14 upon deactivation of said program\_enable signal.

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 16 8. The electrically programmable circuit of claim 6, wherein said electrically  
 17 programmable element has an initial state that is one of high resistance and low resistance  
 18 and has a programmed state that is the other of said high resistance and said low resistance.

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 20 9. The electrically programmable circuit of claim 8, wherein a turn-on resistance  
 21 of said pull-down transistor is substantially at least 10 times of said low resistance and is  
 22 substantially at maximum  $1/10^{\text{th}}$  of said high resistance.

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1           10.     The electrically programmable circuit of claim 6, wherein said pull-down  
2 transistor is an NMOS transistor

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4           11.     The electrically programmable circuit of claim 4, wherein said fuse-switch  
5 comprises:

6           a fuse; and

7           a transistor configured to conduct current through said fuse when activated.

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9           12.     The electrically programmable circuit of claim 11, wherein said transistor of  
10 said fuse-switch is one of NMOS, PMOS, and bipolar transistor.

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12           13.     The electrically programmable circuit of claim 4, wherein said scan chain  
13 comprises a plurality of flip-flops.

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15           14.     A field-repairable system-on-a-chip (SOC) device, comprising:

16           at least one of a plurality of redundant rows and a plurality of redundant columns,  
17 wherein each of said redundant row or said redundant column includes a plurality of fuse  
18 boxes;

19           a plurality of usage indicators configured to indicate that corresponding redundant  
20 rows or corresponding redundant columns are in use;

21           a fuse map sensing circuit configured to sense and save data of said plurality of usage  
22 indicators; and

23           a fuse map scan chain configured to send out data sensed by said fuse map sensing  
24 circuit.

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15. The field-repairable SOC device of claim 14, wherein each of said fuse boxes for said redundant rows and said redundant columns includes:

- a fuse-switch; and
- an electrically programming & sensing unit configured to control said fuse-switch.

16. The field-repairable SOC device of claim 14, wherein each of said usage indicators comprises a fuse.

17. The field-repairable SOC device of claim 14, wherein said fuse mapping circuit comprises:

- a latch configured to latch value of said usage indicator; and
- a transistor configured to cause said latch to latch the value of said usage indicator.

18. The field-repairable SOC device of claim 14, further comprising:

a high voltage generator configured to supply a VPP power in response to a program\_enable signal;

a scan chain configured to receive address bits indicating of word and bit lines that should be corrected; and

a plurality of electrically programmable circuits, wherein each of said electrically programmable circuit comprises:

- an electrically programming & sensing unit configured to receive a signal from said scan chain, said program\_enable signal, and a power-on-reset signal such that upon activation of said program\_enable signal, said electrically programming &



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1                   output a signal which follows said power-on-reset signal to said pull-down  
2 transistor upon deactivation of said program\_enable signal.

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4           21.     A method to package a field-repairable system-on-a-chip (SOC) device at a  
5 factory, comprising:

6           repairing said SOC device, using one or both of redundant rows and columns, prior to  
7 packaging said device;

8           marking usage of all redundant rows and columns;

9           retesting said SOC device; and

10          packaging said SOC device in response to said SOC device completing said retesting  
11 step satisfactorily.

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13          22.     The method of claim 21, wherein said repairing step comprises performing  
14 laser blown repairs on said redundant rows and columns.

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16          23.     The method of claim 21, wherein said marking step comprises blowing usage  
17 indicators corresponding to said redundant rows and columns.

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19          24.     A method to field repair a field-repairable system-on-a-chip (SOC) device at a  
20 factory, comprising:

21          performing a diagnostic test on said SOC device;

22          identifying unused redundant rows and columns;

23          electrically programming any of said unused redundant rows and columns; and

24          retesting said SOC device.

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2           25.    The method of claim 24, further comprising usage marking any used  
3 redundant rows and columns during the electrically programming step.

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5           26.    The method of claim 24, wherein said electrically programming step  
6 comprises:

7           shifting in an address of a defective row or column to a scan chain; and

8           applying a programming power VPP to a electrically programming and sensing unit  
9 associated with said address shifted in said scan chain.

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